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September 30, 2004

By ECFS

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, D.C. 20554

RE: WT Docket No. 03-103

Dear Ms. Dortch:

The purpose of this letter is to incorporate the following documents, prepared by AirCell, Inc., into the above-referenced docket:

- Passenger Benefits from Competition in Broadband Airline Communications
- Providing Deck-to-Deck Coverage

Pursuant to Section 1.1206(b)(1) of the Commission's rules, I am electronically filing one copy of this notice in the above-referenced docket. In addition, I am sending one copy of this notice to each of the Commission staff listed below. Kindly contact me directly with any additional questions.

Sincerely,

Michele Farquhar

Michele C. Farquhar
Counsel for AirCell, Inc.

cc: Richard Arsenault
Shellie Blakeney
Ron Chase
Tom Derenge

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Passenger Benefits from Competition in Broadband Airline Communications

WT Docket No. 03-103

AirCell, Inc.
September 30, 2004

The Need for Competition in Broadband Airline Passenger Communications

The discussion below supports AirCell's position that passengers can only realize the potential for low cost, leading edge voice and broadband data air-to-ground ("ATG") service if there is true competition from up to four licensees in the ATG band.

AirCell believes that the passenger clearly and strongly benefits from competition for the *initial* selection of an ATG provider by each airline, as well as from the ability to *displace or supplement* the initial choice at a later date.

Competition for the initial system purchase provides airlines – and their passengers – with choices and negotiating leverage, which can only result in airline and *passenger* benefits with respect to:

- Passenger services, including pricing, features, ease of inter-carrier roaming;
- WiFi "hotspot" services from one or more recognized providers;
- Length of contract and/or exclusivity provisions;
- Customized product and service solutions – by airline and by type of aircraft
- The availability of new, creative services in the future – either as additions or through a new competitive process.

Two simple illustrations show the dangers of monopoly power:

First, Verizon Airfone *currently* charges Verizon customers a tiny fraction of the price charged to non-Verizon customers (10 *cents*, vs. *four dollars*). 1/ Without competition, what is to prevent a monopoly provider from discriminatory practices to the detriment of the great majority of passengers?

Second, it is well understood that a few large airlines dominate the *volume* of passenger service in the U.S., but that much of the innovation - and profit - in the industry is found among smaller, lower-cost carriers. Absent competition, what is to preclude these smaller customers from finding that no service is available to them, or that only a higher-cost service is available to them, as the result of special agreements between the large airline carriers and the monopoly ATG provider?

Finally, it is worth remembering that the first generation of ATG service has been characterized by a combination of high service costs to passengers, high-priced equipment, low innovation and long-term, "locked-in" contracts – all of which has resulted in a single, failed service offering to passengers.

1/ Verizon Wireless customers pay $0.10 per minute with a $10 monthly fee, or $0.69 per minute without the monthly fee. Other customers pay $3.99 per minute, plus a $3.99 connection fee. *See* <<http://www22.verizon.com/airfone/service/af_service_genrates.html>>.

Contrast that situation with a competitive one in which AirCell is a market participant. AirCell's proposals to airlines are based on: (i) inexpensive, light-weight, easy to install equipment, (ii) aggressive passenger pricing, (iii) provision of services to virtually all passengers (through industry-standard roaming arrangements with their wireless providers), (iv) an attractive pay-back case for the airlines, and (v) no long-term contract commitments. In a competitive market, a prospective airline customer *could and, most likely, would* demand comparable terms from any alternative provider. Moreover, in selecting an ATG service provider, the airline will represent the end users' interests (*e.g.*, on service pricing) as well as its own (*e.g.*, on weight and installation issues), given that it will not want competing airlines to be able to offer travelers a more attractive in-flight communications offering.

Nor do the benefits of a competitive market stop at the point of an initial purchase. An airline would be able to consider proposals to *displace* its initial vendor within the normal, short, technology-replacement cycles applicable in other telecom sectors. Indeed, a competitor who was not selected initially will have every incentive to identify and provide new or improved products and services in order to win subsequent business at that account. Conversely, absent such competition, the entrenched monopoly provider has no incentive to reduce prices, provide innovation or improve the products and services offered to the passenger – as evidenced by the results of the last 20 years.

Only Terrestrial Systems Can Provide Cost-Effective Voice and Broadband Services to the Domestic Market

Verizon Airfone would have the Commission staff believe that there is significant competition between the proposed voice and broadband services to be provided in the ATG spectrum and that of various satellite-based services. This is disingenuous and demonstrably false.

Satellite-based systems *cannot* compete effectively in the domestic market – either on a cost to the passenger or a cost to the airline basis – *now or in the foreseeable future.* Therefore the simple question becomes: what does it take to engender meaningful competition in ATG services that will result in the best service at the lowest cost to passengers and airlines?

There is indeed a place and need for satellite-based solutions outside of the U.S. However, such solutions *will not be competitive in the U.S. with ATG product and service offerings.* The reasons are simple: cost, weight and complexity to the airlines, and either limited (non-broadband) functionality or high price to the passenger.

In its *ex parte* filing of September 13, 2004, AirCell reviewed in detail the various current and anticipated satellite offerings, a summary of which is included below:

- The Inmarsat system of next generation satellites is planned to offer higher data rates in the mid-2006 timeframe (up to 432 Kbps), but the proposed service rates will be in the \$2 to \$3 per minute range. Even assuming this represents a competitive offering to the passenger, the cost to equip an airline (which approaches \$500,000 *per plane*), and the effect of the equipment weight (a minimum of 60-70 pounds) on fuel and other operating costs makes this alternative non-competitive with ATG.

- Connexion by Boeing and others have rolled out broadband communication systems based on Ku-band satellites which can and will support broadband, but these systems are burdened with the same or higher cost and weight airborne equipment (estimated to be \$500,000 to \$700,000 per aircraft and 800-1,200 lbs), resulting in a cost to passengers anticipated at \$3 to \$6 per minute.

- Finally, low earth orbit satellite systems ("LEOS") such as Iridium and Globalstar have been successful in offering airborne (primarily voice) communications at a relatively low cost. However, available data rates with these systems are very low (below 9.6 Kbps) – in fact, too low to support the services that will be required by the airlines and their passengers.

Thus, although aeronautical satellite services offer a broad range of services at vastly varying costs, none is suited to providing the cost-effective broadband solution required by U.S. airlines and their passengers. Low-cost, terrestrially-based broadband services are the only logical solution to serving the vast majority of aircraft flown by U.S.-based airlines, and satellite services cannot be viewed as competitors to this approach.

Providing Deck-to-Deck Coverage

AirCell, Inc.
September 30, 2004

Deck-to-Deck coverage

<u>Summary</u>

AirCell has analyzed the practical issues associated with providing "deck-to-deck" coverage (from en route altitudes to the airport runway) in the vicinity of airports, and concludes that such coverage is readily achievable under both AirCell's two and four overlapping license proposals. AirCell provides herein an evaluation of one approach by which this can be accomplished, while maintaining full broadband coverage for the cabin and passengers (while causing no undue service degradation for any ATG licensee). The approach outlined also assures that no one ATG carrier will be able to gain an appreciable competitive advantage over other carriers by virtue of site selection, and will not unfairly limit the ability of any carrier to expand system capacity in the vicinity of the airport.

AirCell's earlier analyses had focused on the engineering issues associated with providing services to en route aircraft, essentially those that are flying at altitudes of 10,000 feet and higher. This is consistent with current FAA regulations, which require that all Personal Electronic Devices (PEDs) be turned off while below this altitude. Recently however, questions have been raised regarding the potential need to serve aircraft traffic below this level for any "non-PED" traffic originating during departures and approaches, and in the event that the FAA ever modifies its current usage prohibitions for PEDs.

In response to these questions, AirCell has done detailed technical analyses of various airport scenarios, including the case study below using the very busy Chicago O'Hare International airport. AirCell has determined that deck-to-deck coverage can be enabled by ensuring that sites serving the airport (1) limit transmit power towards the horizon (by a combination of uptilted antennas and/or reduced transmitter power), and (2) observe minimum site spacing requirements as described below (thus ensuring that later entrants will not be precluded from providing full airport service due to an earlier carrier's site layout). These simple requirements, described starting on page 18, will assure that carriers' coexistence and their abilities to offer deck-to-deck coverage will require no intervention from the FCC.

Therefore, Airfone's assertions concerning the AirCell proposals' inability to provide deck-to-deck coverage under its two or four licensee scenario are clearly WRONG. Airfone represents that there is a mandatory base station separation of 102 miles under AirCell's proposal, but this has never been a requirement. Airfone also claims that both AirCell and Boeing "admit interference will limit service below 10k," but AirCell has not made such an admission, and it clearly and now unequivocally refutes this claim. Finally, Airfone's repeated statements that AirCell's approach precludes service in areas around airports or precludes deck-to-deck service are fully refuted below.

Background

AirCell has proposed that the FCC can license up to four service providers in the ATG services bands of 849-851 and 894-896 MHz by implementing rules that effectively isolate competing systems. The proposed rules take advantage of multiple system isolation mechanisms that are available for airborne systems:

- *Cross-duplex operation.* The number of carriers hosted within the ATG band can be doubled by having them operate on opposite duplex (or reverse banding) schemes. The first carrier uses the lower band for ground-air links and the higher band for air-ground links, while the second carrier utilizes the lower band for air-ground links and the higher band for ground-air links.
- *Frequency offsets.* Commercial systems that are candidates for providing broadband services to aircraft have channel bandwidths of 1.25 MHz. By offsetting the carrier assignments within the 2 MHz bands, with partial overlap of channel assignments, additional isolation between the two systems can be achieved.
- *Cross polarization.* The number of carriers operating within the ATG band can be redoubled, to a total of four, by utilizing the further isolation available by assigning orthogonal polarizations to the carriers.

When these mechanisms are incorporated into ATG licensing, the isolation between systems has been shown to allow each carrier to operate with negligible impact from other service providers.

In typical terrestrial mobile systems, where carriers effectively "share" the same spectrum with minimal geographic separation (as along MSA or MTA borders) carriers must evaluate and manage intersystem interference created between one carrier's base stations and the other carrier's mobile terminals. In practice, this type of interference has existed and been managed for many years. In the cross duplex system described by AirCell, the interference potential exists between mobile terminals ("air-air") and between base stations ("base-base"). Such potential interference can be managed with no greater effort than has been required between geographically separated carriers with terrestrial mobile systems.

Air-Air Interference. The FAA's minimum aircraft separation requirements (1000' vertical separation and 5 nm horizontal separation) assure that there are only minimal cross system impacts between aircraft – the combination of horizontal spacing, the shielding created by the body of the lower altitude aircraft and the fact that aircraft (mobiles) maintain the minimum required transmit power level in an EVDO type broadband system provides adequate signal isolation between the aircraft operating at worst case separation distances.

Base-Base Interference. Base-base interference is controlled by assuring that nearby base sites have adequate isolation. For cross-country sites (i.e., those serving en-route aircraft), the spacing between cells of a carrier is so great that carriers can easily avoid interfering with each other with minimal coordination (considerably less than what is typically required between adjoining cellular systems, for instance). In the vicinity of major airports, there is a greater density of aircraft, and it is anticipated that a carrier may eventually need multiple sites to provide the required capacity. In order to allow carriers to provide comparable levels of service within the vicinity of airports while precluding high levels of base-base interference, AirCell recommends limiting the transmit power towards the horizon (implemented by a combination of uptilted antennas and/or reduced transmitter power). Further, an intra-system site spacing requirement will assure that later market entrants will not be precluded from providing service in the vicinity of the airport due to the first carrier's site layout.

This analysis by AirCell extends its earlier work to evaluate any additional requirements that may be needed to allow up to four carriers to provide "deck-to-deck" coverage – coverage from en route aircraft altitudes to the airport runway. The earlier conclusion that multiple competitive carriers could, in total, support more total capacity than would likely be supported by a single carrier utilizing the spectrum can also be clearly extended to the deck-to-deck scenario as well.

Deck-to-deck service requirements:

Aircraft in the vicinity of airports operate in a tightly controlled airspace. As a case study, we evaluated the requirements of Chicago's O'Hare International (ORD) to characterize the service area around a very busy airport.

O'Hare has 4 "arrival gates," each roughly 40 miles from the airport, as indicated on Figure 1. Aircraft cross these points at about 11,000' altitude, and air traffic control (ATC) routes each aircraft to an active runway selected for landing. ORD has 6 runways, and each may be used from either direction, thereby defining 12 different approach corridors to the airport. Each approach corridor has a glide slope of 3 degrees, extending out 4-6 nautical miles, to altitudes ranging from 2100' to 2500' (1450' to 1850' AGL measured from the runway altitude of ~650') (see http://www.airnav.com/airport/ORD) . ATC routes each aircraft between the arrival gate and the outer marker that defines the beginning of the approach corridor, typically maintaining a minimum aircraft horizontal separation of 5 nm (5.75 statute miles) and 1000' vertical separation. The last 2-4 miles before reaching the approach corridor, the aircraft is generally at an altitude of 2500' (AMSL), and can easily transition to the glide slope.

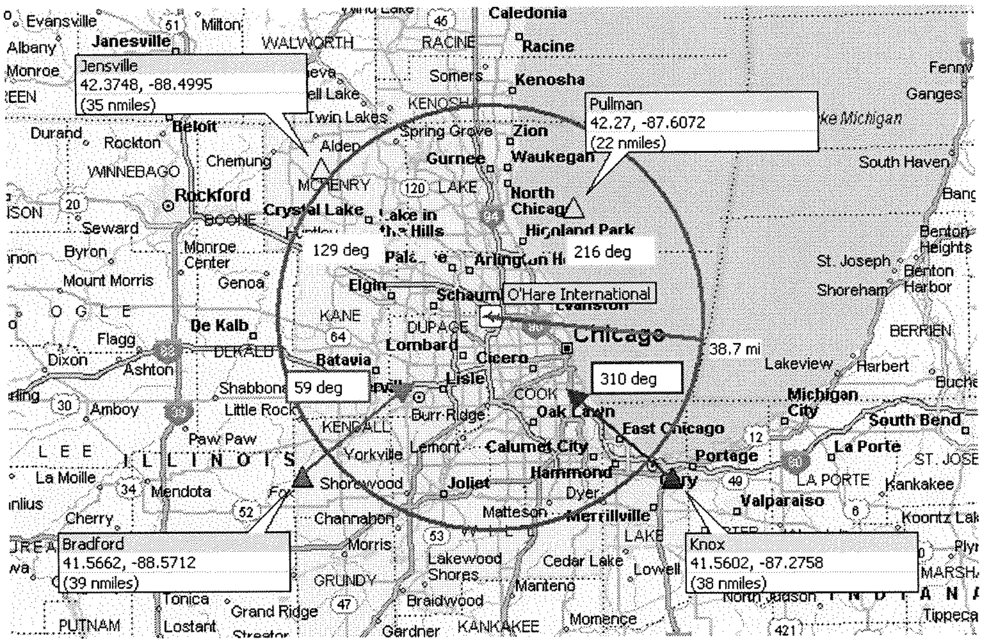

Figure 1. Arrivals airspace factors - O' Hare International Airport (ORD)

Figure 2 below shows the lower limit of aircraft positions that are expected from arriving aircraft - essentially a modified bowl-shaped airspace. The altitude shown in this graph is referenced to the average runway elevation, and may be considered typical of most major airports.

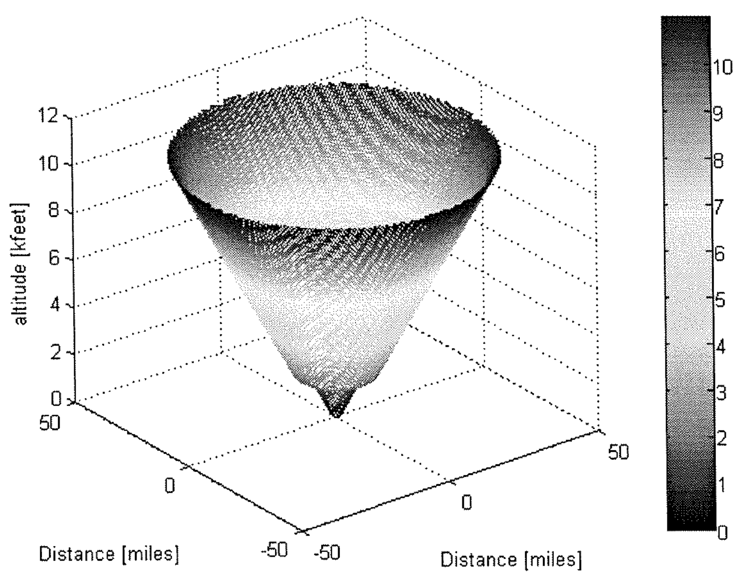

Figure 2. Arrival airspace "bowl"

Aircraft departing from O'Hare must climb to 4000' altitude within 8 miles, then climb to and maintain 5000' until advised by ATC. Typically, once departing aircraft are 15-20 miles from the airport, they will be cleared to climb away to en route flight paths at altitudes much above 10,000'. With reference to Figure 2, this means that departing aircraft are within the "bowl" defined by the flight paths for arriving aircraft.

The objective of the study presented in this document is to determine how multiple carriers may each cover the space inside the bowl while also:

- assuring that no carrier has a particular competitive advantage over other carriers by virtue of site selection
- assuring that levels of base-base interference will not unduly degrade service capabilities of any carrier and will allow sufficient data rates to offer a broadband user experience;
- not limiting the ability of any one carrier to expand system capacity in the vicinity of the airport, and
- not creating a requirement that other carriers may have to modify their systems to allow another carrier to expand its capacity.

Airport network configurations:

Aircraft spend only a small fraction of their flight schedules within the arrival/departure airspace of an airport. Furthermore, current FAA regulations heavily restrict the use of passenger devices that will generate the levels of communications traffic that are expected while aircraft are en route to their destinations. At most airports, these low levels of traffic will likely be served by a single base station.

As-yet-unforeseen changes to FAA regulations may increase the level of traffic generated by arriving/departing aircraft. In order to avoid unnecessarily restricting the growth of network capacity, the operators should be able to expand airport configurations in fashions similar to those that they would use to expand capacity on the cross-country portion of their networks. In particular, carriers should be free to add additional base stations in a "cell-splitting" approach, dividing the served airspace into smaller segments, in order to increase the overall capacity of the local network. Our proposal allows for this.

Aircraft often spend extended periods of time positioned at ramps or on taxiways, where passengers could generate large levels of traffic. If deck-to-deck traffic levels are large, the levels of traffic generated on the ground will be much larger since many more aircraft are located there than are between the runways and 10,000 feet altitude. Large levels of traffic can easily be accommodated seamlessly by provisioning aircraft with dual band radio systems capable of communicating with terrestrial facilities while on the ground, and handing over to ATG facilities when airborne. This will assure seamless service for the users of all on-board services. (Note: this does not involve individual passenger units handing over to terrestrial mobile or hotspot facilities; rather, it is a handover of the broadband "pipe" carrying the such traffic from air to ground, in much the same manner that handovers will occur from ATG cell to ATG cell while airborne.) Such terrestrial facilities can be designed to meet large capacity requirements, accommodating virtually any demand level with no impact on the capacity of the ATG system. While a discussion of the design of such a terrestrial network is outside the scope of this document, it is worth noting that there are a number of options available. For instance, an ATC carrier could form relationships with terrestrial license holders that are operating networks with air interfaces similar to that used by the ATG carrier (e.g. EVDO could be used for ATG service, and could also be used for the terrestrial service through an arrangement with a PCS or cellular licensee.)

Two carrier scenarios. ATG base stations positioned equidistantly from the center of the airport will offer each carrier an equal opportunity to serve the airspace in the vicinity of the airport – in effect each site would be placed on (or near) a ring centered on the airport. We first evaluated a case with two cross-duplexed carriers serving an airport, and determined that each carrier can have as many as three sites around an airport while maintaining adequate base-base isolation and providing good coverage of the airspace. While there likely would be only a need for one site per carrier at the outset, AirCell's approach would facilitate as many as three sites on the ring per carrier. If additional capacity is ever required, it would be very feasible to add additional cells farther from the airport, further subdividing the airspace to allow each site to serve a smaller portion of the overall traffic. This approach therefore meets the objective of providing a network evolution path should one or more of the carriers need additional capacity within the airport airspace.

Figure 3 illustrates the base-base interference levels for six sites, three from each carrier, located on a 6-mile radius circle centered on the airport.

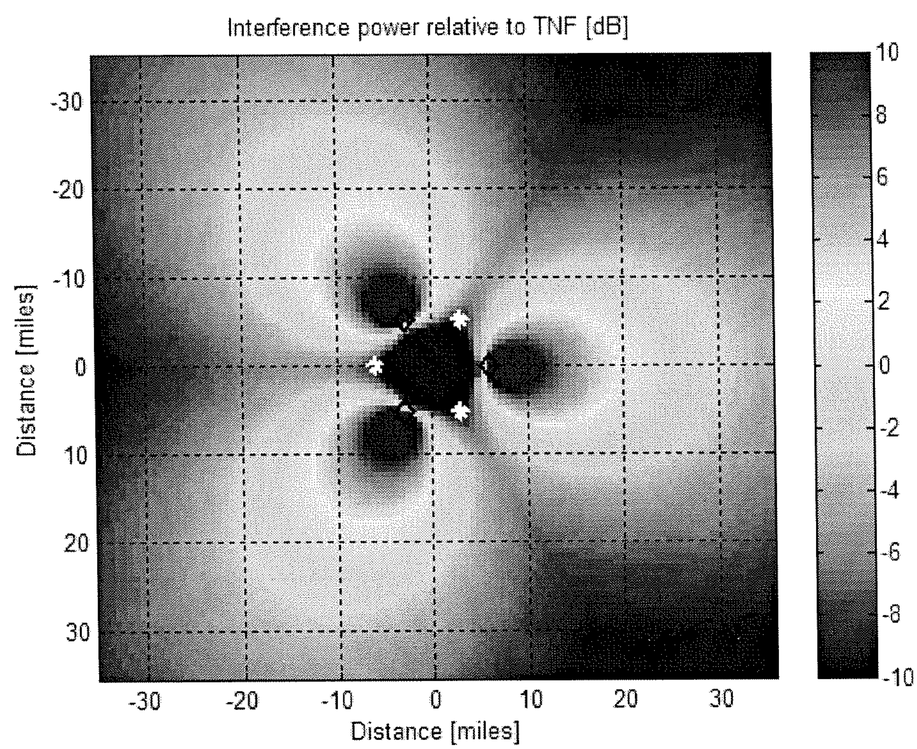

Figure 3. Base to base interference, two carriers, three sites each, 6 miles ring

The "interfering" carrier (sites marked with black ◇) has three sites located at azimuths 90, 210 and 330 degrees on the ring, and the second carrier has three sites located at azimuths 30, 150 and 270 degrees (marked with a white *). Spacing between cross-duplexed sites is 6 miles. The transmitter output power is 1 watt (+30 dBm) per site, and cable losses were budgeted at 3 dB per antenna.

Carriers that need three sites to provide adequate capacity at an airport will require that the three antenna systems be directional, with the antennas pointed away from the airport, in order to avoid excessive self-interference. In addition, to minimize interference between base stations of the cross-duplex providers, it is required that a null of the radiation pattern be placed on the horizon. The antenna patterns used in the analysis shown in Figure 3 are shown in Figure 4 below.

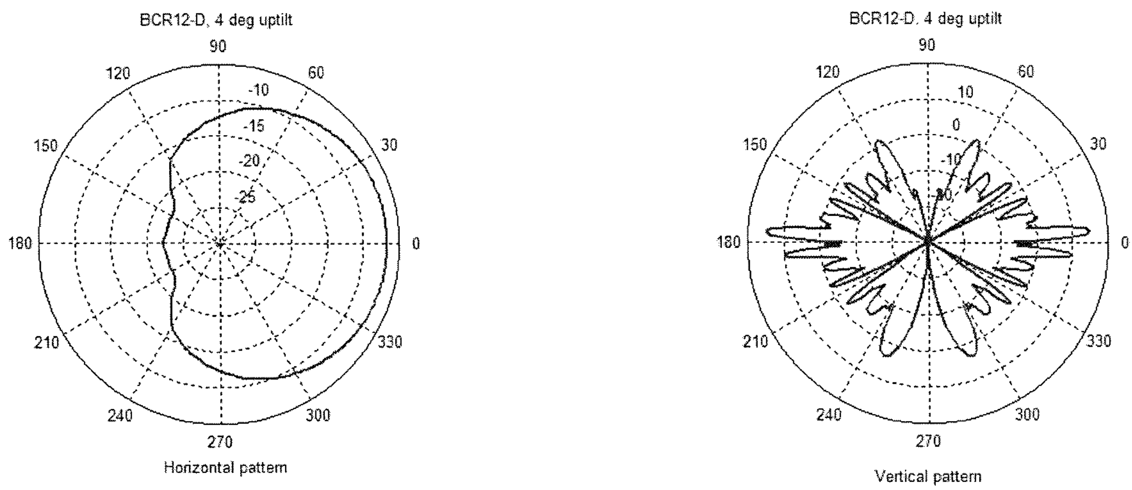

Figure 4. Directional antenna patterns

These patterns are from commercially available antennas (Celwave BCR12D), inverted to provide uptilt rather than downtilt, and with a slight modification to aim the null directly onto the horizon (4 degree tilt rather than 3 degree tilt). Antennas most suited for ATG service are usually manufactured to a specific set of requirements for uptilt and upward null fill, and any other application specific needs. The use of this particular antenna is not intended to indicate that they are the most suited for this application, but rather to indicate that acceptable antenna performance can be readily achieved.

The thermal noise floor (TNF) for a 1.25 MHz receiver with a 4 dB noise figure is –109 dBm Cable losses were budgeted at 3 dB per site. The transmitter output power used to calculate interference levels was 1 watt (+30 dBm), which is sufficient given the high antenna gains and shorter path lengths in the airport vicinity.

The plot shows the margin to the TNF created by signals from the active sites. While a 3 dB margin below the TNF is adequate to assure minimal interference with base station capacity, this particular example shows that the interference is about 9 dB below the thermal noise at the cross-duplexed site locations

When arrival/departure airspace is initially covered (and perhaps for a very considerable time following), it is expected that many carriers will implement a single site per airport. In that case, if a carrier uses one of the three sites on the ring around the airport, an initial omni antenna configuration can provide coverage of the entire "bowl", expansion to three sites on the ring in the future is straightforward, and the base-base interference levels can be managed within acceptable limits. Figure 5 below illustrates the base-base interference impacts of a single omni site located on a six-mile ring.

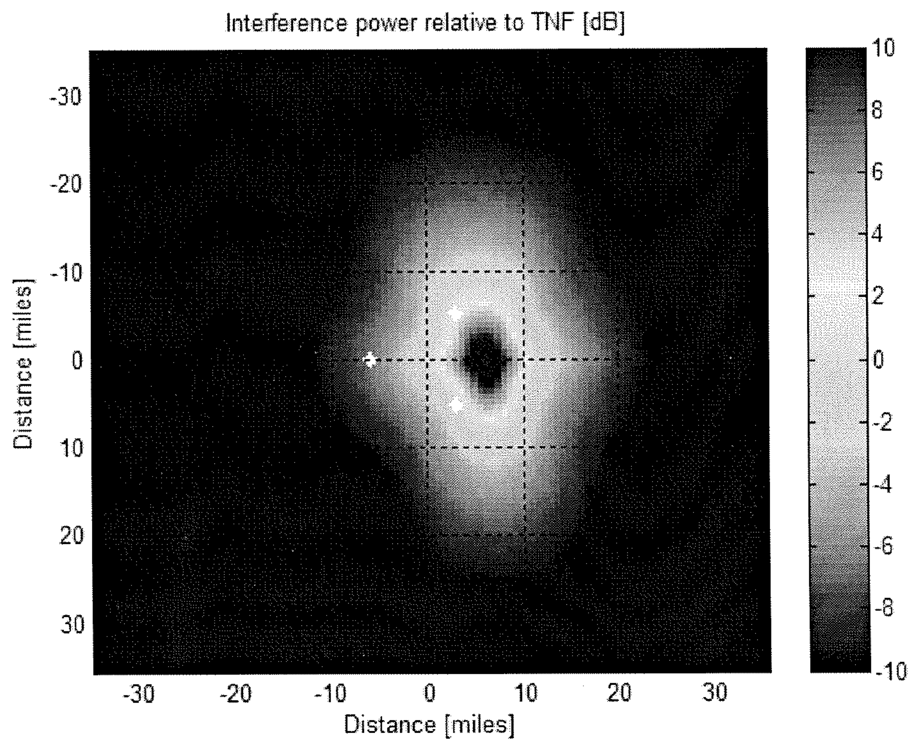

Figure 5. Base to base interference, two carriers, one site each, 6 miles ring

The antenna patterns for this analysis are shown in Figure 6 below. Note that there is some minor pattern eccentricity for this particular antenna, a by-product of the techniques used in its construction, and this is why the pattern in Figure 5 is not perfectly circular.

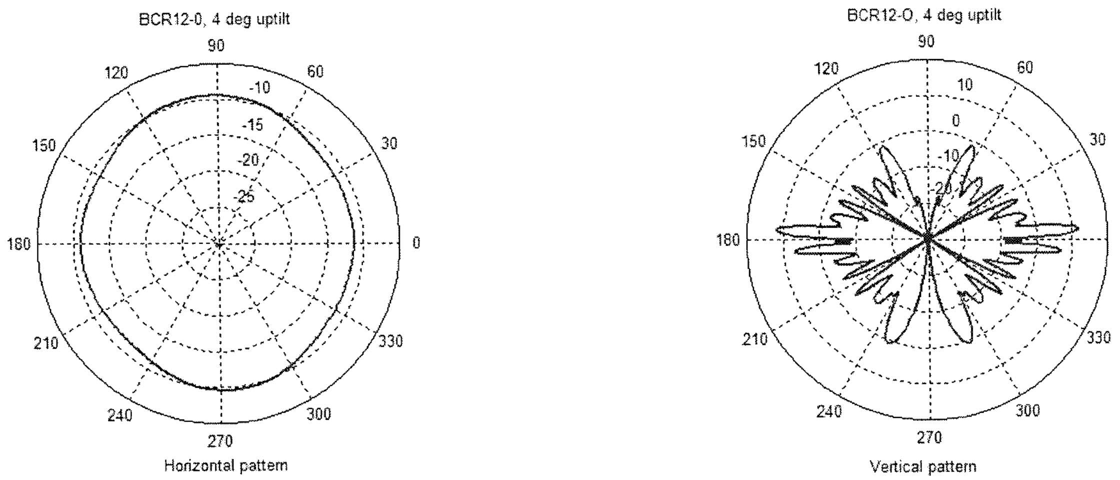

Figure 6. Omnidirectional antenna patterns

With the BCR12O antennas, the interference for an omni site on the farthest cross-polarized site is over 6 dB below the thermal noise floor. Note that for the two closer site locations, the 1 dB interference to TNF ratio would require that some additional isolation would be required for two omni sites. If either site has a directional antenna, there would be adequate discrimination towards the omni site located at 90 degree azimuth to assure that interference levels would be well below the TNF.

The levels of interference will of course be further reduced if the radius of the site ring is increased. Figure 7 below illustrates the impact of this radius on interference levels for radii from 3 to 12 miles. Base-base interference objectives can be met for configurations with sites located six miles or more from the airport center, provided that omni configurations use sites on the opposite sides of the airport. A need for some site location flexibility suggests that an 8 mile ring radius be considered as a practical minimum, in order to allow a reasonably large site "search ring" to be used.

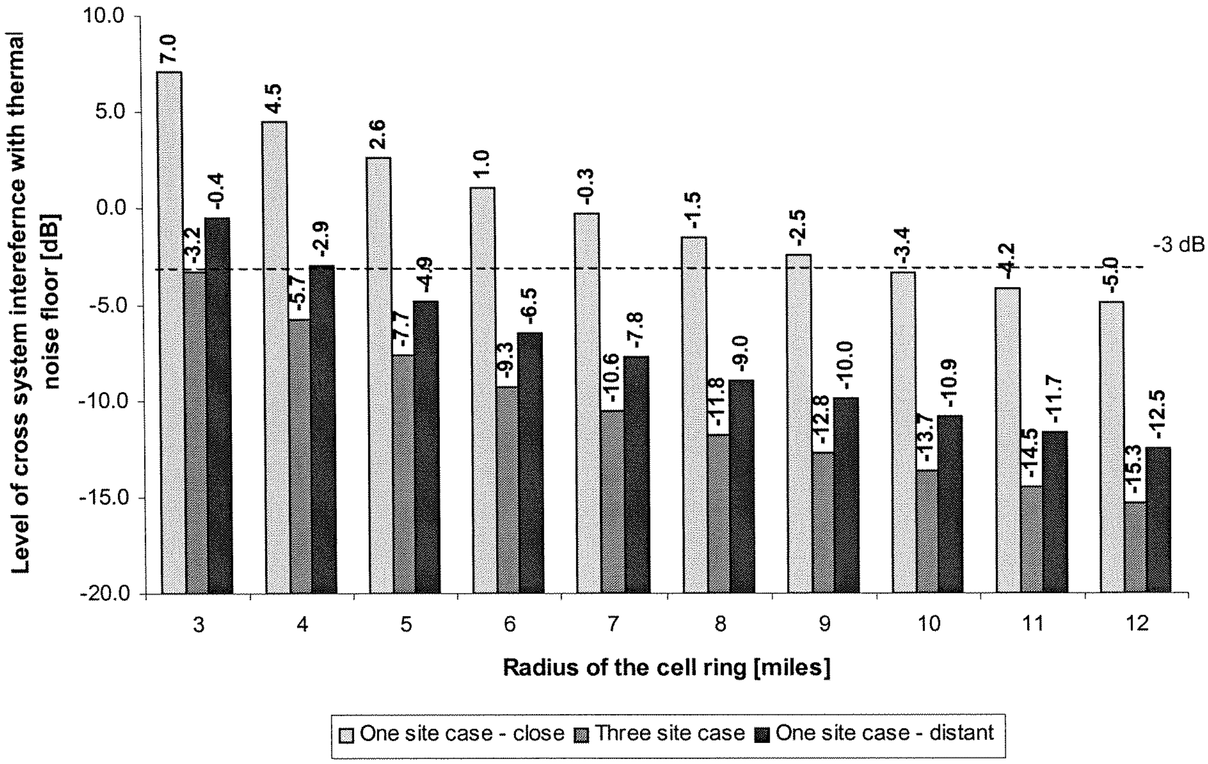

Figure 7. Base-base interference levels versus distance of sites from airport center.

The single omni site and the three directional site configurations were both evaluated to assure that adequate network performance could be provided. The forward link data rate achievable was evaluated, with self-interference from the three sectored sites providing the primary limitation on throughput. Reverse link performance was evaluated by determining the reverse link data transmit power required to support a single EVDO terminal per aircraft operating at a rate of 153.6 kbps, on a system loaded to the 50% pole point. (Note – the maximum reverse link rate achievable per aircraft will be a function of the number of terminals "ganged" together on an aircraft and the overall loading from other aircraft active on the same base station.)

Figures 8 and 9 below show the forward link data rates that can be achieved with rings of 6 miles and 9 miles respectively. The forward link provides data rates of 2457.6 kbps over the majority of the area. In the coverage boundary between sites the rates are lower, with a minimum rate of 614.4 kbps being experienced in a very small portion of the area.

Figures 10 and 11 show that reverse link data rates of 153.6 kbps can be maintained over the entire arrival/departure airspace. The maximum transmit power required to sustain this rate is about +10 dBm. These low transmit power requirements also assure that aircraft can operate at adequate data rates even if cross-duplexed aircraft are landing on parallel runways.

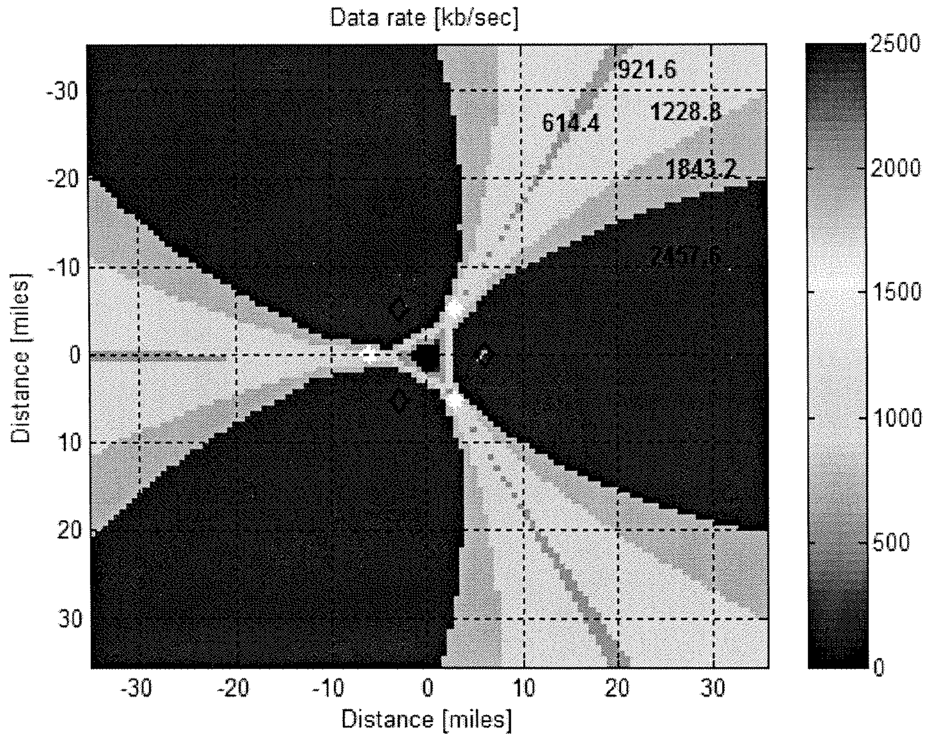

Figure 8. Forward link rate on the "bowl" for cell ring of 6 miles

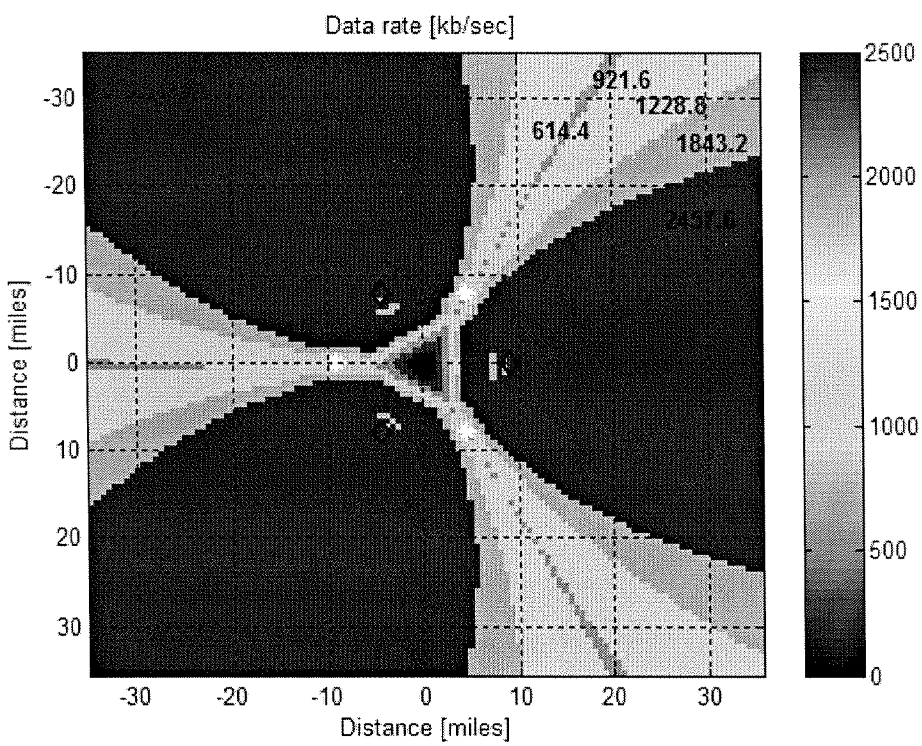

Figure 9. Forward link rate on the "bowl" for cell ring of 9 miles

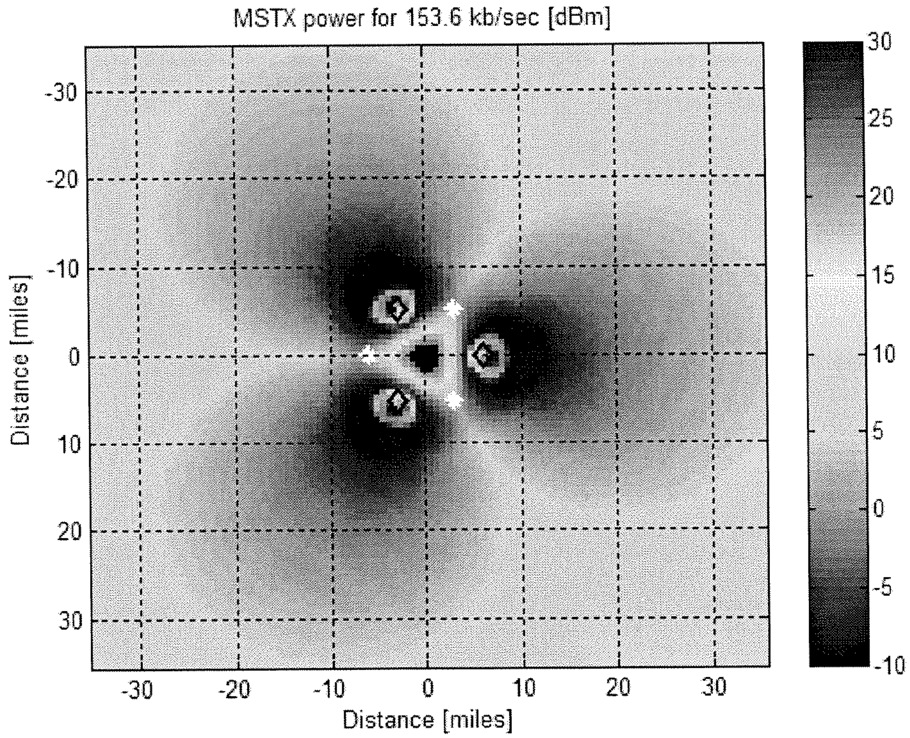

Figure 10. Reverse link TX power, 153.6 kbps, 50% loading, cell ring of 6 miles

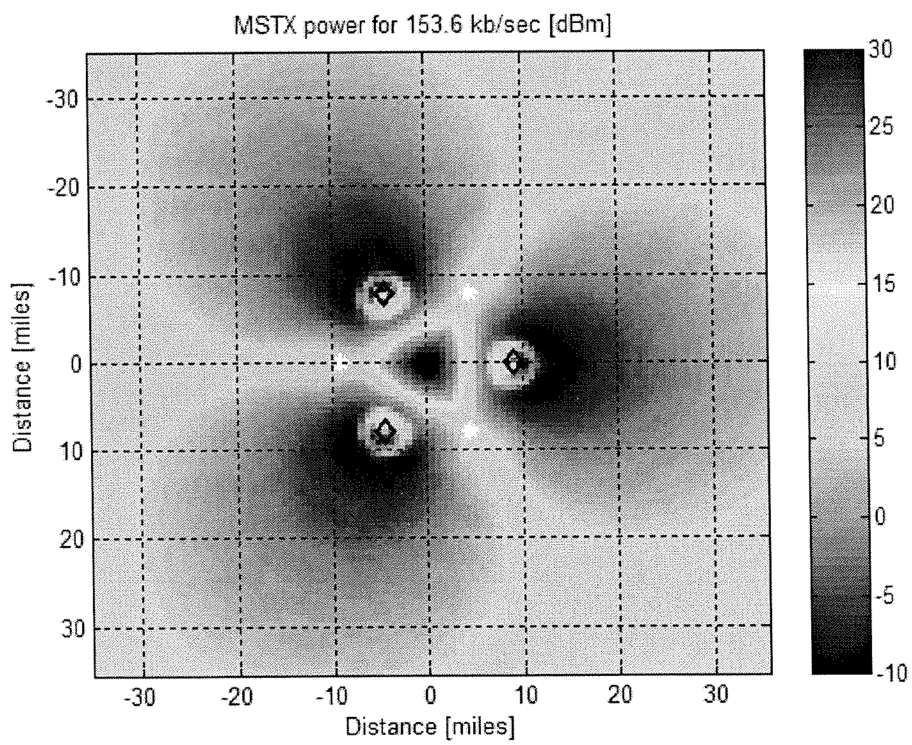

Figure 11. Reverse link TX power, 153.6 kbps, 50% loading, cell ring of 9 miles

Figures 12-15 provide similar data for the single cell omni configurations. Forward link data rates are maintained at 2457.6 kbps over the entire area, and the maximum transmit power required to support 153.6 kbps on the reverse link does not exceed 18 dBm.

Note that the area in the immediate vicinity of the airport (a radius of 1.5-2 miles) will have minimal coverage due to the combination of the antenna pattern null on the horizon and the likelihood of "clutter" between the airport and the base station locations. By handing off at an altitude of 200-300' AGL between the ATG system and the terrestrial service that will be required to provide ramp, taxiway and runway service, continuous service may be provided from gate to en route altitudes. Therefore, hand-off to/from the ATG network to the terrestrial system covering the ramps, etc., will take place between 200-300' AGL under AirCell's approach to facilitate deck-to-deck service.

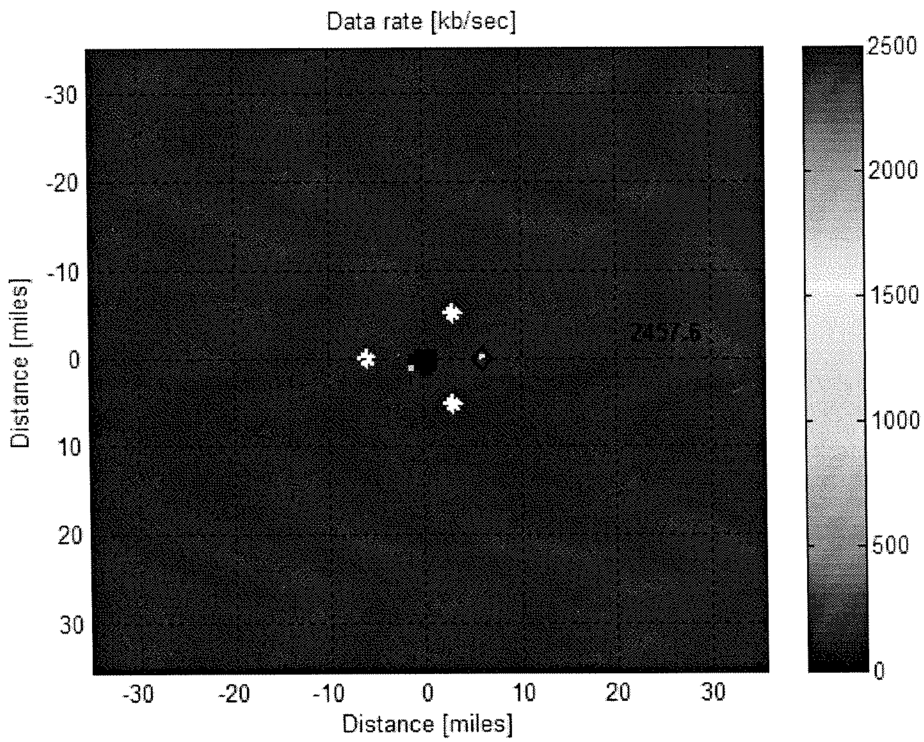

Figure 12. Forward link rate on the "bowl" for cell ring of 6 miles

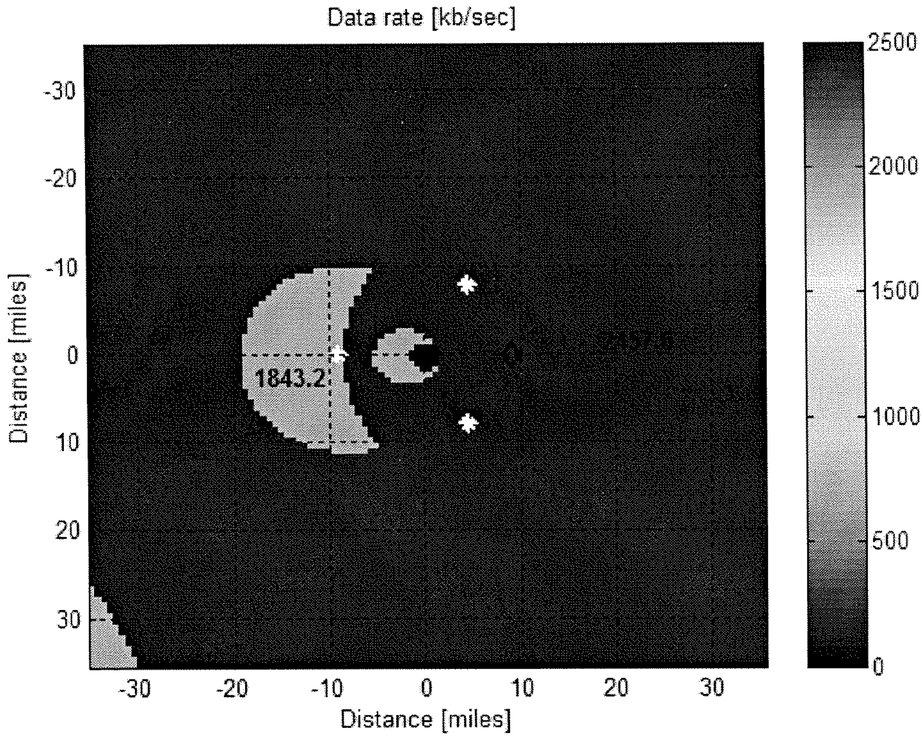

Figure 13. Forward link rate on the "bowl" for cell ring of 9 miles

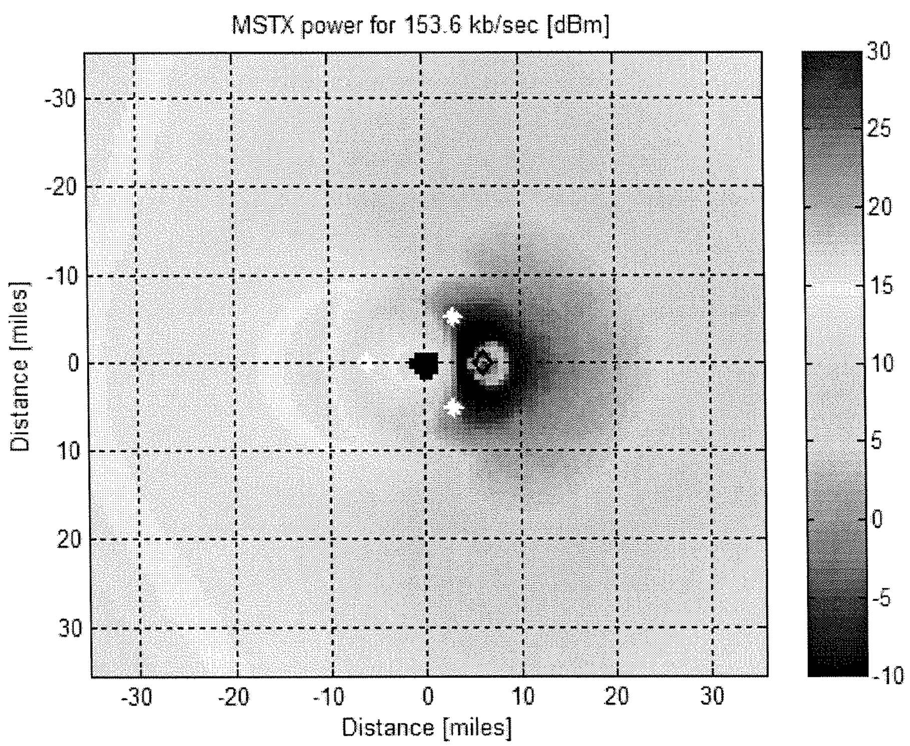

Figure 14. Reverse link TX power, 153.6 kbps, 50% loading, cell ring of 6 miles

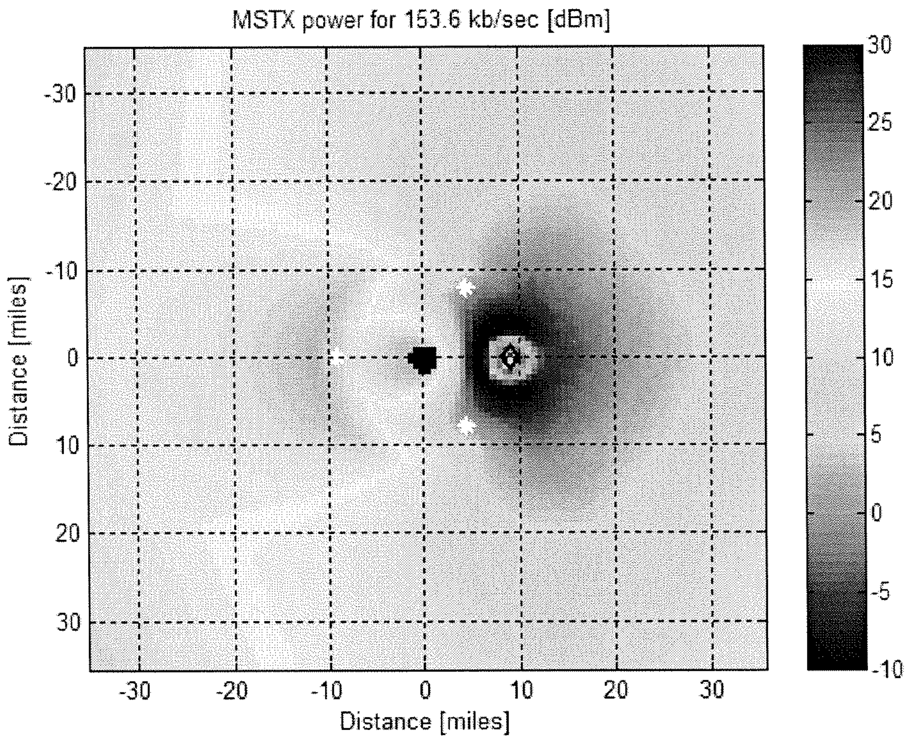

Figure 15. Reverse link TX power, 153.6 kbps, 50% loading, cell ring of 9 miles

This analysis demonstrates that it is entirely feasible for two carriers to deploy full deck-to-deck broadband service to serve the airspace in the vicinity of the airport, while avoiding service degradation caused by base-base interference. Provided carriers respect reasonable site location rules and some easily achieved antenna system configurations, service may be provided by omni sites, with the option for either or both carriers to expand capacity by using a network of directional sites. AirCell's analysis above shows how as many as three sites per carrier can be configured, although one site per carrier will be adequate for initial provision of broadband ATG service.

Four carrier scenarios. To allow four carriers to serve the airport, we evaluated the impact of adding additional sites on the ring, employing cross-polarized antenna system to provide isolation from the initial two carriers. The same mechanisms that supported such operation in cross-country routes apply to the airport environment.

The licenses for four carriers would combine cross-duplexing, cross polarization and channel offsets as shown in Table 1 below.

Table 1. Four carrier spectrum plan[1]

System	Pol.	Initial Channels (MHz)		Final Channels (MHz)	
		Ground	Air	Ground	Air
Existing	V	849.00 - 849.60	894.00 - 894.60	-	-
System 1	V	894.75 - 896.00	849.75 - 851.00	894.00 - 895.25	849.00 - 850.25
System 2	V	849.75 - 851.00	894.75 - 896.00	849.75 - 851.00	894.75 - 896.00
System 3	H	894.00 - 895.25	849.00 - 850.25	894.75 - 896.00	849.75 - 851.00
System 4	H	849.00 - 850.25	894.00 - 895.25	849.00 - 850.25	894.00 - 895.25

Since each system is required to observe spatial separation from the two cross-duplexed systems, base-base interference will not be an issue even with the additional cross-polarized sites added to the ring to accommodate the additional carriers. The possibility of near-far problems is also entirely avoided, because co-duplexed but cross-polarized systems will be in close proximity (if not in fact collocated) as a consequence of both being distanced from the cross-duplexed sites. Path losses from aircraft to cross-polarized, co-duplex sites will be at very similar levels due to the minimum distance between the site ring and any aircraft "within the bowl". Paths to all aircraft from any base station will be line-of-site, signal polarization will not be affected by any signals reflected from the ground due to the presence of the strong line-of-site component and the discrimination against ground reflections provided by the uptilted antennas. There will be no near-far problems for cross-polarized sites that are on the same ring position.

This analysis demonstrated that the objectives initially established can be met:

- base-base interference levels can be acceptably managed by locating serving cell sites on a ring surrounding the airport,
- no carrier will have a distinct service advantage,
- carriers will be able to expand service capacity, and
- expansion by one carrier will not require modifications of systems of other carriers in the area.

The remaining task is to develop a set of easily understood, simple rules that, if adopted, will assure that carriers' coexistence requires no intervention by the FCC.

[1] This table reflects the channel assignments originally proposed by AirCell, which could require additional filtering to avoid interference to nearby channels when implementing systems based upon currently available terrestrial system equipment. If the FCC determines that 1.5 MHz rather than 1.25 MHz assignments are warranted, these assignments may be modified with very little impact on total inter-system isolation.

Airport Rules discussion:

"Management" of base-base interference has been demonstrated by using uptilt antennas with nulls on the horizon and inter-system site spacing that provides adequate isolation between sites. While sites spaced several miles apart can often be selected to provide significant obstruction loss due to zero to negative Fresnel zone clearance, a very conservative approach is to assume free space loss between sites. A ring of six miles radius will result in spacing between cell sites of six miles, and this has been shown to be sufficient to provide adequate isolation between cross-duplexed sites with free space path losses.

An approach that will generally preserve minimum cell spacing of 6 miles, while allowing a search ring of 2 miles for each site, appears to be reasonable. A ring radius of 8 miles is therefore suggested, with the following rules supporting site locations:

1. no site may be constructed closer than 8 miles from the center of the airport; where the center of the airport is the latitude and longitude of the airport as defined by the FAA for navigation purposes. Carriers may have the option of locating sites farther from the airport.
2. the first site constructed at an airport (by any carrier) will define the relative orientation of all subsequent sites on the ring; the candidate locations of the other sites will be defined as by Nx60 degree offset from the azimuth extending from the airport center through the first site. Sites may be constructed within +/-7.5 degrees of these azimuths
3. co-duplexed sites must be located at candidate locations defined by 0 and +/-120 degrees from the first site, and cross duplexed sites may be located at +/- 60 degrees and 180 degree locations.

15 degrees of arc is 1/24 of a complete circle, and is equivalent to ~2 miles of the circumference of an 8 mile radius circle. Thus +/- 7.5 degrees of azimuth corresponds to about 2 miles of site search area.

In order to permit effective coordination between airport sites and surrounding sites, it is further proposed that a 10 mile maximum be set for the greatest distance between the airport and a site "on the ring". Figure 16 below illustrates all of these rules governing candidate site locations on the airport ring.

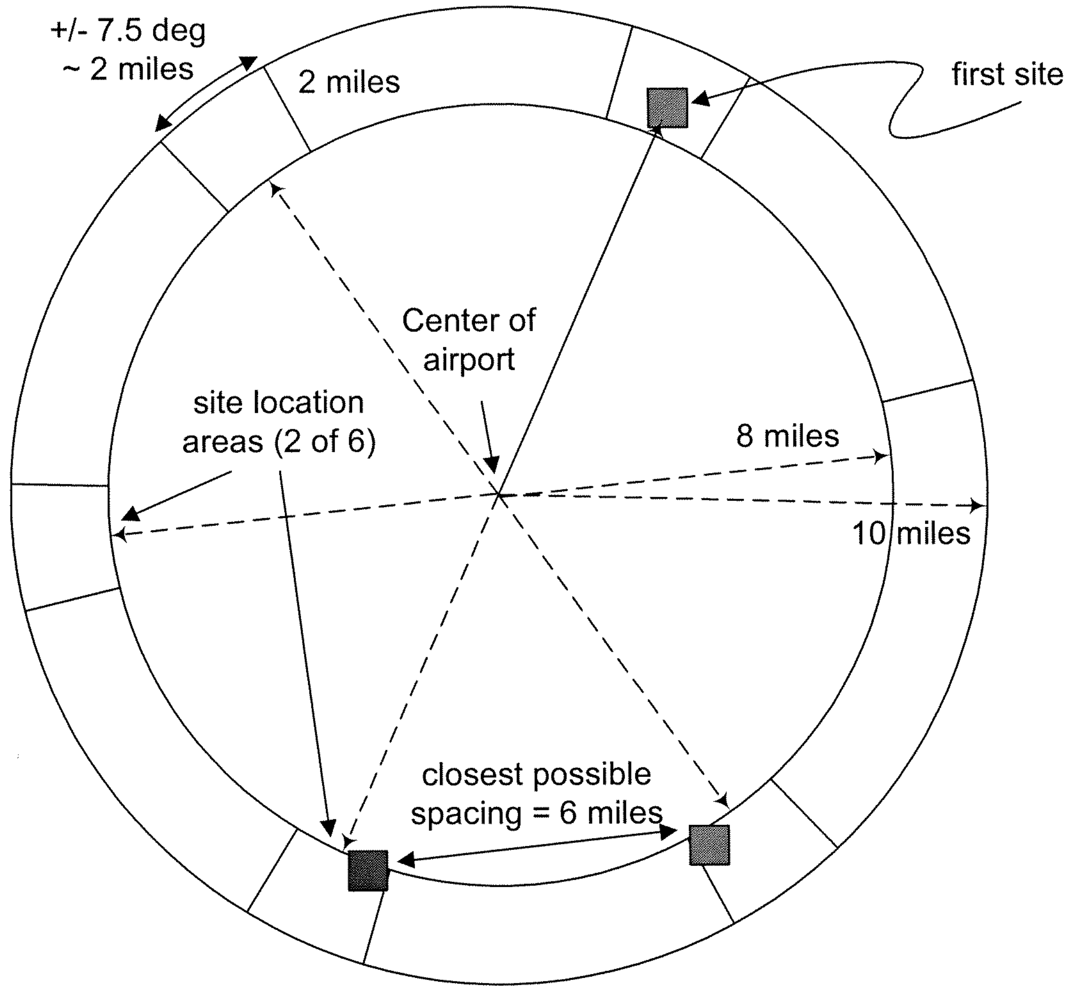

Figure 16. Site location ring around airport, showing 6 site location areas, separated by 60 degrees

Figure 17 below illustrates the application of these rules for sites serving the Chicago O'Hare airspace, for the first carrier. The co-duplexed cross polarized carrier would also locate sites in the vicinity of #1, 3, and 5, and the cross-duplexed carriers would be located in the vicinity of locations marked #2, 4, and 6.

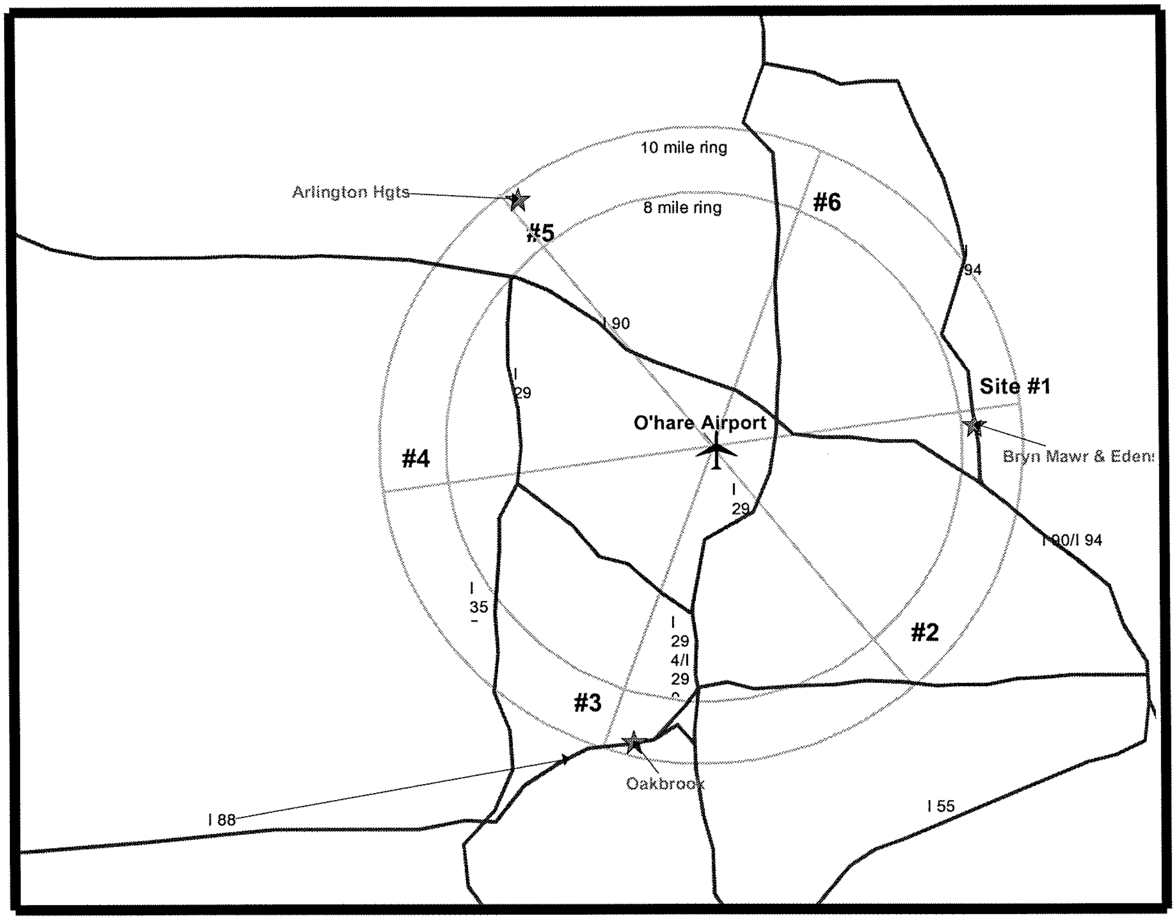

Figure 17. Chicago O'Hare airport – serving sites

The second factor in supporting base-base isolation requires limiting the power transmitted towards the horizon. The antennas used in the omni analysis transmitted a maximum Effective Isotropic Radiated Power of - (30-3-10 = 17dBm) dBm towards the horizon. The directional antennas provided several dB of additional isolation towards the cross-duplex sites, and are not the "limiting case". It is also clear that similar levels of isolation could be obtained by a using lower transmit powers and antennas with less discrimination, or by using more discrimination and higher transmit powers. The following rule will allow carriers the freedom to design their systems with certain knowledge of the incident signal levels that may constitute interference, and design their sites accordingly:

1. the maximum EIRP transmitted towards any cross-duplexed candidate site location shall not exceed 16 dBm.

Summary/Conclusion:

Deck-to-deck service can be implemented in the vicinity of airports with relatively simple constraints to guide the selection of sites. The coordination activities that may be required by carriers are simple when compared to those that are typically undertaken along many geographic boundaries between cellular or PCS carries that share the same band.

The rules suggested permit the development of a healthy, competitive environment among ATG service providers, and are significantly less complex than those that are currently embedded in the FCC regulations. AirCell notes that, notwithstanding the complexity of the current rules and the large number of mobile carriers operating in hundreds of different service areas, there have rarely been complaints directed to the FCC as a result of carriers coming to conflict over the rules.

Summary - BTS-BTS Interference, Licensing Plans and Rules

AirCell, in its prior filings and presentations to the Commission Staff related to the Air to Ground (ATG) licensing approaches (FCC Docket 03-103), stated and still continues to believe that inter-system BTS-BTS isolation can be achieved, allowing multiple licensees to offer broadband competition. This section summarizes all requirements for primary cross-country coverage as well as deck-to-deck coverage near airports.

These rules serve the following objectives:

1. Offer a level playing field for all licensees and no undue advantage to the first system constructed
2. Control BTS-BTS interference to at least 3dB below receivers' thermal noise floor, so there is no appreciable impact on system performance.
3. Offer enough flexibility for service providers to control different parameters (BTS location, distance, terrain obstruction or location beyond radio horizon, antenna /tower heights, Tx power, Tx/Rx antenna patterns, etc.) to achieve BTS-BTS isolation while providing room for optimal performance and capacity growth
4. Place the accountability for interference compliance on licensees so there is mutual burden and interest to minimize interference (and eliminate the need for FCC coordination).

Licensing plans/frequencies are re-stated in these rules with some modifications that allow 3 MHz bandwidth per licensee so that each operator has the flexibility to deal with any guardband requirements and/or broadband technology choices.

TWO-LICENSEE SPECTRUM PLAN RULES:

1. LICENSE AND SPECTRUM ALLOCATION

The frequencies in Table 1 indicate the Transmit frequencies of the Ground stations. Initially, existing ATG services must move to channel blocks 8, 9 and 10 and clear the remaining channel blocks. Initial channel assignments are for the broadband systems during the transition time period the incumbent needs to phase out the current narrowband ATG system. Final channel assignments shall apply once the incumbent has discontinued use of the narrowband service.

The channel assignments reflect 3 MHz (2x1.5 MHz) per licensee. AirCell believes that guard-band requirements can be addressed using conventional, inexpensive filters, permitting the use of 2x1.25 MHz assignments. However, AirCell's proposed spectrum plan can also easily accommodate 1.5 MHz bandwidth per licensee thereby providing each licensee the flexibility to deal with guard-band requirements using filtering or channel spacing.

Table 1

System	Pol.	Initial Channels1 (MHz)		Final Channels (MHz)	
		Ground	Air	Ground	Air
Existing	Any	849.00 - 849.60	894.00 - 894.60	-	-
System 1	Any	894.50 - 896.00	849.50 - 851.00	894.00 - 895.50	849.00 - 850.50
System 2	Any	849.50 - 851.00	894.50 - 896.00	849.50 - 851.00	894.50 - 896.00

2. BTS (BASE STATION) LOCATION, DISTANCE AND POWER LEVELS

Site definitions. There are two types of sites defined.

- "Primary Coverage Sites" meet the following criteria:
  - Maximum Effective Isotropic Radiated Power (EIRP) transmitted towards the horizon of +53 dBm
  - Receive antenna with a maximum gain 13 dB towards the horizon

- "Capacity Sites" meet the following criteria:
  - Maximum Effective Isotropic Radiated Power (EIRP) transmitted towards the horizon of +16 dBm
  - Receive antenna with a null (loss) of at least 11 dB towards the horizon

Airport zone. In the vicinity of an airport, the initial sites built must conform to the airport ring requirements:

- *Airport Ring*. Up to three Capacity Sites can be constructed by each service provider on a ring around the airport. The requirements for site placement in the ring are:

  - the inner radius is 8 miles, the outer radius is 10 miles; sites may be built between the inner and outer radii.
  - 6 equally spaced areas are available for locating sites, with the first being defined as the location of the first site constructed +/- 7.5 degrees, and the other 5 being defined by 60xN +/-7.5 degrees from the center of the first area, for values of N=1 to 5.
  - co-duplexed sites are in the first, third and fifth areas, cross-duplexed sites are in the second, fourth and sixth areas (each area is approximately 2 miles square.)

- Outside the Airport Ring additional Capacity Sites may be developed subject to the following rules:
  - A Capacity Site shall be at least 10 miles away from any existing or potential cross-duplexed site location on an Airport Ring.
  - A Capacity Site shall be at least 10 miles away from other cross-duplexed Capacity Site.
  - A Capacity Site shall be at least 45 miles away from any cross-duplexed Primary Coverage Site.
  - A Capacity Site's transmission shall not cause receive power levels of more than -98 dBm (in the 1.5 MHz bandwidth) at a radial distance of 45 miles referenced to an isotropic antenna at 100 feet above ground level.
  - A Capacity Site's transmission shall not cause receive power levels of more than -122 dBm (in the 1.5 MHz bandwidth) at a radial distance of 65 miles, referenced to an isotropic antenna at 100 feet above ground level.

Primary coverage zones. Outside the Airport Ring described above, a service provider can locate a "Primary Coverage Site" anywhere subject to meeting all of the following rules:

- A Primary Coverage Site shall be at least 55 miles away from the center of any airport
- A Primary Coverage Site shall be at least 65 miles away from any cross-duplexed Primary Coverage Site.
- A Primary Coverage Site shall be at least 45 miles away from any cross-duplexed Capacity Site.
- A Primary Coverage Site's transmission shall not cause receive power levels of more than -98 dBm (in the 1.5 MHz bandwidth) at radial distances of 45 miles referenced to an isotropic antenna 100 feet above ground level.
- A Primary Coverage Site's transmission shall not cause receive power levels of more than -122 dBm (in the 1.5 MHz bandwidth) at radial distances of 65 miles referenced to an isotropic antenna 100 feet above ground level.

FOUR-LICENSEE SPECTRUM PLAN RULES:

All rules in the two-licensee spectrum plans are applicable to the four-licensee spectrum plan except as noted below.

1. LICENSE AND SPECTRUM ALLOCATION

The frequency allocation are provided in Table 2.

Table 2

System	Pol.	Initial Channels (MHz)		Final Channels (MHz)	
		Ground	Air	Ground	Air
Existing	V	849.00 - 849.60	894.00 - 894.60	-	-
System 1	V	894.50 - 896.00	849.50 - 851.00	894.00 - 895.50	849.00 - 850.50
System 2	V	849.50 - 851.00	894.50 - 896.00	849.50 - 851.00	894.50 - 896.00
System 3	H	894.00 - 895.50	849.00 - 850.50	894.50 - 896.00	849.50 - 851.00
System 4	H	849.00 - 850.50	894.00 - 895.50	849.00 - 850.50	894.00 - 895.50

2. BTS (BASE STATION) LOCATION, DISTANCE AND POWER LEVELS

Same as two-licensee spectrum plan.

3. BTS (BASE STATION) ANTENNA PATTERN

The receive and transmit antenna pattern at any BTS of a service provider shall be at least 20 dB below the main beamwidth for angles from 15 to 90 degrees above the horizon.

Appendix A

Following table provides examples of isolation link budget for three scenarios.

Minimal distances in the rules contribute to BTS-BTS isolation through free space path loss and obstruction losses from earth bulge and other obstructions. The calculations are for a nominal case of 100 ft antenna height on an average terrain. If a service provider has to locate in conditions other than this, it is possible that the isolation from the distances will be more or less than what is in the table. In such cases, a service provider is expected to offer at least the minimal isolation through a combination of reduced EIRP towards horizon, increased distance between sites, lower antenna height, higher discrimination in the receive antenna and coordination with other service providers.

Link Budgets - Isolation

Interferer Site		Airport site	Primary coverage site	Primary coverage site
Victim Site		Airport site	Primary coverage site	Airport site
Transmitter				
TX power	(dBm)	30.0	43.0	43.0
Cable loss	dB	3.0	3.0	3.0
Antenna gain	dB	12.0	13.0	13.0
Discrimination - horizon	dB	23.2	0.0	0.0
EIRP on horizon	(dBm)	15.8	53.0	53.0
Receiver				
Discrimination - horizon	dB	23.2	0.0	23.2
Antenna gain	dB	12.0	13.0	12.0
Cable loss	dB	3.0	3.0	3.0
Thermal Noise Floor - 3dB	(dBm)	-112.0	-112.0	-112.0
Required total path loss	dB	113.5	175.0	150.8
Path length	mi.	8.0	65.0	45.0
Free space loss		113.5	131.6	128.5
Path obstruction required	dB	0.0	43.4	22.3